

Citation:

Deierlein AL, Siega-Riz AM, Herring A. Dietary energy density but not glycemic load is associated with gestational weight gain. *Am J Clin Nutr*. 2008 Sep; 88 (3): 693-699.

PubMed ID: [18779285](#)

Study Design:

Prospective cohort

Class:

B - [Click here](#) for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To determine whether total gestational weight gain and the weight gain ratio (observed weight gain or expected weight gain) increase with increasing energy density and glycemic load.

Inclusion Criteria:

- Women at their second prenatal visit with a gestation ≤ 20 weeks
- Aged ≥ 16 years
- Carrying a singleton fetus
- Planning to continue care at the clinic
- Access to a telephone.

Exclusion Criteria:

- Women who did not have pregravid body mass index (BMI) and weight gain information
- Pregnancies that did not result in a live birth
- Women with missing or implausible dietary information.

Description of Study Protocol:**Recruitment**

Women were recruited for the third cohort of the Pregnancy, Infection and Nutrition Study at selected prenatal clinics in North Carolina from January 1, 2001 through June 30, 2005.

Design

Prospective cohort study.

Dietary Intake/Dietary Assessment Methodology

Subjects completed a self-administered 100-item Block-98 food-frequency questionnaire (FFQ) that was modified to include local foods and focus on a three-month time frame and solicit information about portion sizes.

Blinding Used

Not applicable.

Intervention

Not applicable.

Statistical Analysis

- T-tests of means, ANOVA, and tests of linear trend were used to examine glycemic load and energy density across sociodemographic strata
- Linear regression was used to model glycemic load and energy density with the two main outcome variables, total gestational weight gain and weight gain ratio
- Variables were assessed as both effect modifiers and confounders.

Data Collection Summary:

Timing of Measurements

- Information on diet during the second trimester was collected at 26-29 weeks of gestation
- Data on physical activity patterns were collected at 17-22 and 27-30 weeks gestation
- Body weight was measured near the time of delivery and pre-pregnancy weight was self-reported.

Dependent Variables

- Gestational weight gain (the difference between a woman's pregravid weight (self-reported) and her weight measured near the time of delivery)
- Weight gain ratio (a ratio of observed total weight gain over expected total weight gain up until the last prenatal visit using the weight gain recommendations from the 1990 Institute of Medicine report).

Independent Variables

- Daily energy intake
- Daily energy density (the amount of energy per gram of food consumed)
- Average glycemic index
- Glycemic load (the product of the glycemic index and the carbohydrate (CHO) content of the foods contributing to it).

Control Variables

- Pregravid BMI
- Maternal age
- Race
- Income
- Education
- Parity

- Gestational age and residual energy intake
- Smoking status
- Marital status
- Smoking status
- Third-trimester recreational physical activity.

Description of Actual Data Sample:

- *Initial N*: 2,006 recruited
- *Attrition (final N)*: 1,231
- *Age* (at conception):
 - 16-24 years (18.6%)
 - 25-29 years (28.8%)
 - 30-34 years (35.6%)
 - 35-47 years (17.0%)
- *Ethnicity*:
 - White (74.5%)
 - Black (16.2%)
 - Other (9.3%)
- *Other relevant demographics*:
 - 17.5% had at most completed grade 12
 - 78.9% were married
- *Anthropometrics*: For pregravid BMI
 - 14.3% were underweight
 - 53.0% were normal weight
 - 10.2% were overweight
 - 22.5% were obese
- *Location*: North Carolina.

Summary of Results:

Adjusted Linear Regression Model by Quartile of Energy Density with Total Gestational Weight Gain and Weight Gain Ratio

Variables	Mean Energy Density (Quartile 1)	Mean Energy Density (Quartile 2)	Mean Energy Density (Quartile 3)	Mean Energy Density (Quartile 4)
Total gestational weight gain (kg) [N=1,231]	Reference	0.49 (-0.40, 1.37)	1.13 (0.24, 2.01)*	1.08 (0.20, 1.97)*
Beta coefficient^a (95% CI)				

Weight gain ratio [N=1,147] Beta coefficient^b (95% CI)	Reference	0.03 (-0.09, 0.15)	0.08 (-0.04, 0.20)	0.13 (0.006, 0.24)*
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a: Beta coefficient adjusted for pregravid BMI, gestational age and residual energy intake

b: Beta coefficient adjusted for pregravid BMI, education, smoking status, third trimester recreational physical activity and residual energy intake

*P<0.05

Adjusted Linear Regression Model by Quartile of Glycemic Load with Total Gestational Weight Gain and Weight Gain Ratio

Variables	Mean Glycemic Load (Quartile 1)	Mean Glycemic Load (Quartile 2)	Mean Glycemic Load (Quartile 3)	Mean Glycemic Load (Quartile 4)
Total gestational weight gain (kg) [N=1,186] Beta coefficient^a (95% CI)	Reference	-0.22 (-1.12, 0.68)	-0.06 (0.95, 0.84)	0.82 (-0.11, 1.75)
Weight gain ratio [N=1,111] Beta coefficient^b (95% CI)	Reference	-0.03 (-0.15, 0.09)	0.02 (-0.10, 0.14)	0.09 (-0.03, 0.22)

a: Beta coefficient adjusted for pregravid BMI, maternal age, race, education, income, parity, gestational age and residual energy intake

b: Beta coefficient adjusted for pregravid BMI, maternal age, marital status, education, income, smoking status, third trimester recreational physical activity and residual energy intake

Key Findings

- Weight gain during pregnancy was inadequate in 13.6% of women, adequate in 22.2% and excessive in 64.2%
- Women in the last quartile of energy intakes had weight gain ratios that were 0.13 (0.006, 0.24) units greater than those for women in the first quartile (P=0.04)
- Women in the third and fourth quartiles of mean energy density gained significantly (P=0.01 and 0.02, respectively) more weight than did women in the first quartile
- Glycemic load was not associated with gestational weight gain outcome.

Author Conclusion:

- Dietary patterns of pregnant women differed significantly across many sociodemographic and behavioral characteristics, with the greatest contrasts seen for glycemic load
- Dietary energy density was significantly associated with total gestational weight gain and weight gain ratio
- Dietary glycemic load was not associated with either outcome of gestational weight gain
- Mean energy density and glycemic load values did not differ across Institute of Medicine categories of gestational weight gain.

Reviewer Comments:

Author-identified limitations:

- An FFQ was used to measure dietary glycemic load and energy density (these questionnaires are not specifically designed to capture this information), but the authors believe they were reasonably measured
- Pregravid weight was self-reported, and underestimation of pregravid weight may have over-estimated gestational weight gains.

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions

1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	N/A
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	N/A

Validity Questions

1.	Was the research question clearly stated?	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	Was the selection of study subjects/patients free from bias?	Yes

2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	Were study groups comparable?	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	N/A
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	N/A
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	N/A
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	Was method of handling withdrawals described?	Yes
4.1.	Were follow-up methods described and the same for all groups?	Yes
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	Was blinding used to prevent introduction of bias?	No

5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	N/A
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	No
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were intervening factors described?	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	N/A
6.8.	In diagnostic study, were details of test administration and replication sufficient?	Yes
7.	Were outcomes clearly defined and the measurements valid and reliable?	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes

7.7.	Were the measurements conducted consistently across groups?	Yes
8.	Was the statistical analysis appropriate for the study design and type of outcome indicators?	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	No
8.7.	If negative findings, was a power calculation reported to address type 2 error?	No
9.	Are conclusions supported by results with biases and limitations taken into consideration?	Yes
9.1.	Is there a discussion of findings?	N/A
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	Is bias due to study's funding or sponsorship unlikely?	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes